NAME, SURNAME AND STUDENT NUMBER (* required fields):

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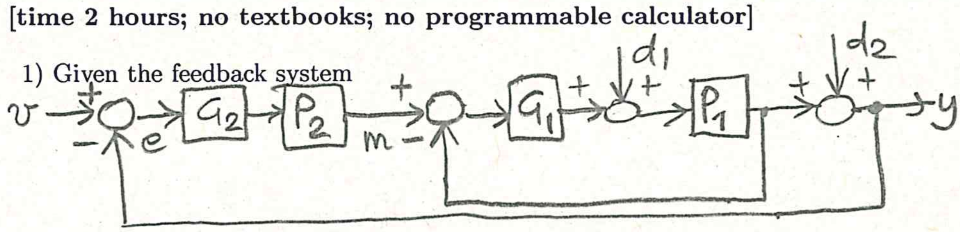
CONTROL SYSTEMS - 8/1/2019 (B)

[time 2 hours; no textbooks; no programmable calculator]

1) Given the feedback system



with $P_1(s) = \frac{1}{s+2}$, $P_2(s) = \frac{s+1}{s+0.1}$, design one-dimensional controller $G_1(s)$ and two-dimensional controller $G_2(s)$ such that the feedback system (from v, d_1, d_2 to y) has the following properties:

(i) asymptotic stability (use the Nyquist criterion)

(ii) zero steady state error to constant inputs v,

(iii) zero steady state output to constant disturbances d_1, d_2 and zero steady state output to unit ramp disturbances $d_1(t) = t$

and the open loop system (from e to y) has the largest possible crossover frequency ω_t^*.

2) Given $P(s) = \frac{s+2}{s(s-2)(s+10)^2}$:

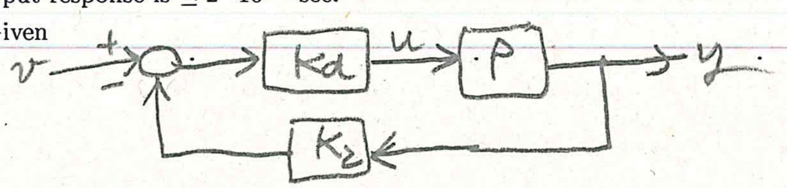
a) Draw the root locus of $P(s)$ using the Routh criterion to determine the exact picture on the imaginary axis

b) Determine, if any, a controller $G(s) = K$ such that the feedback system $W(s) = \frac{PG(s)}{1+PG(s)}$ is asymptotically stable.

c) Determine a one-dimensional controller $G(s)$ such that the feedback system $W(s) = \frac{PG(s)}{1+PG(s)}$ is asymptotically stable with poles having negative real part ≤ -1 and the absolute value of the steady state error to unit ramp inputs ($v(t) = t$) is ≤ 0.2.

d) Determine a controller $G(s)$ such that the feedback system $W(s) = \frac{PG(s)}{1+PG(s)}$ is asymptotically stable and the 5%-settling time of the step output response is $\leq 2 \cdot 10^{-2}$ sec.

3) Given



with $P(s) = \frac{1}{s+3}$ find, if possible, K_r and K_d such that the steady state output response $y_{ss}(t)$ of the closed-loop system with input $v(t) = \sin t$ is $y_{ss}(t) = 2(\cos\frac{\pi}{3}\sin t + \sin\frac{\pi}{3}\cos t)$.